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<b>(21) International Application Number:</b> PCT/US91/03475 <b>(22) International Filing Date:</b> 17 May 1991 (17.05.91) <b>(30) Priority data:</b> PCT/US90/06395 5 November 1990 (05.11.90) EP <i>(34) Countries for which the regional or international application was filed:</i> 689,988 23 April 1991 (23.04.91) US 695,304 3 May 1991 (03.05.91) US <b>(60) Parent Application or Grant</b> <b>(63) Related by Continuation</b> US 689,988 (CIP) Filed on 23 April 1991 (23.04.91) <b>(71)(72) Applicant and Inventor:</b> GUNNERMAN, Rudolf, W. [US/US]; 4100 Folsom Blvd., 9D, Sacramento, CA 95814 (US).		<b>(74) Agent:</b> GIOIA, Vincent, G.; Christie, Parker & Hale, P.O. Box 7068, Pasadena, CA 91109-7068 (US). <b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU*, TD (OAPI patent), TG (OAPI patent), US. <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i>
<b>(54) Title:</b> AQUEOUS FUEL AND COMBUSTION METHOD FOR ENGINES  <b>(57) Abstract</b>  An aqueous fuel for an internal combustion engine comprises water from about 20 percent to about 80 percent by volume of the total volume of fuel, and a carbonaceous fuel selected from ethanol, methanol, gasoline, kerosene fuel, diesel fuel, carbon-containing gaseous or liquid fuel, or mixtures thereof. A method for combusting an aqueous fuel in an internal combustion engine is provided that produces approximately as much power as the same volume of gasoline.		

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**AQUEOUS FUEL AND COMBUSTION METHOD FOR ENGINES****Field of the Invention**

This invention relates to a novel aqueous fuel for an internal combustion engine and to a novel method of combusting such fuel in an internal combustion engine as well as to a novel fuel mixture which results from the introduction of the aqueous fuel into the combustion chamber of an internal combustion chamber in the presence of a hydrogen-producing catalyst.

**Background of the Invention**

There is a need for new fuels to replace diesel and gasoline for use in internal combustion engines, especially engines used in motor vehicles. Internal combustion engines operating on gasoline and diesel fuel produce unacceptably high amounts of pollutants which are injurious to human health and may damage the earth's atmosphere. The adverse effects of such pollutants upon health and the atmosphere have been the subject of great public discussion. Undesirable pollutants result from combustion of carbonaceous fuel with combustion air that contains nitrogen. The relatively large amounts of air used to combust conventional fuels is therefore, a primary reason for unsatisfactory levels of pollutants emitted by vehicles with internal combustion engines.

**Summary of the Invention**

A novel fuel and fuel mixture, and novel method of combustion, have been discovered which will reduce pollutants produced by internal combustion engines operated with conventional carbonaceous fuels such as gasoline, diesel fuel, kerosene fuels, alcohol fuels such as ethanol and methanol, and mixtures thereof. The new fuel mixture is also much less expensive than carbonaceous fuel such as gasoline or diesel fuel because its primary ingredient is water. The term "internal combustion engine" as used herein is intended to refer to and encompass any engine in which carbonaceous fuel is combusted with oxygen in

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1 one or more combustion chambers of the engine. Presently known such engines include piston displacement engines, rotary engines and turbine (jet) engines.

5 The novel aqueous fuel of the present invention has less than the potential energy of carbonaceous fuels but is nonetheless capable of developing at least as much power. For example, an aqueous fuel of the invention comprising water and gasoline has about 1/3 the potential energy (BTU's) of gasoline, but when used to operate an internal combustion engine, it will produce approximately as much power as compared with the same amount of gasoline. This is indeed surprising and is believed to be due to the novel fuel mixture that results from the release of hydrogen and oxygen and the combustion of hydrogen when the novel aqueous fuel is introduced to a combustion chamber of an internal combustion engine and combusted with relatively small amounts of combustion air in the presence of a hydrogen-producing catalyst by the novel method of the present invention.

10 In its broadest aspects, the aqueous fuel of the present invention comprises substantial amounts of water, e.g., up to about 70 to about 80 percent by volume of the total volume of aqueous fuel, preferably 25% to 75% and still more preferably, 40% to 70%, and a gaseous or liquid carbonaceous fuel such as gasoline, ethanol, methanol, diesel fuel, kerosene-type fuel, other carbon-containing fuels, such as butane, natural gas, etc., or mixtures thereof. In utilizing this fuel with the novel method of the present invention, aqueous fuel and combustion air are introduced into the engine's fuel introduction system, for receiving and mixing fuel and combustion air and introducing the fuel/air mixture into the combustion chamber(s). Such systems may include a conventional carburetor or fuel injection system. Although it is not necessary for the practice of the invention, when using an engine with a carburetor, the combustion air may be preheated to from about 350°F to about 400°F as it enters the carburetor. When using an engine with a fuel injection system, the combustion air may be preheated from about 122°F to about 158°F as it enters the fuel injection system. The air/fuel mixture is introduced into the combustion chamber or chambers and combusted in the presence of a hydrogen-producing catalyst which facilitates the dissociation of water in the aqueous fuel into hydrogen and oxygen so that the hydrogen is combusted with the carbonaceous fuel to operate the engine.

20 25 The term "hydrogen-producing catalyst" is used herein in its broadest sense. A catalyst as generally defined is a substance that causes or accelerates activity between two or more forces without itself being affected. In the present invention it is known that without this substance present in the combustion chamber, as described herein, combustion of the aqueous fuel does not take place in such a way as to produce the desired degree of power to operate the internal combustion engine.

30 35 Without intending to be bound by theory, it is believed that upon generation of an electric spark in a combustion chamber with a wet atmosphere in the presence of poles formed of hydrogen-producing catalyst, the electrical discharge electrifies the mass of water present in liquid or gaseous form, e.g., steam vapor, to enable the electric charge to travel to the negatively charged catalytic poles to effect discharge of the electric charge. Dissociation of water molecules appears to occur upon exposure of the mass of water

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1 molecules to the electric charge in combination with the heat of combustion resulting from  
combustion of the carbonaceous material component of the aqueous fuel during the  
compression stroke which, along with combustion of released hydrogen, provides the power  
to operate the engine.

5 Although in the presently preferred embodiment it is preferred to use two catalytic  
poles of hydrogen-producing catalyst, one, or more than two poles, also may be used to  
disperse the electric charge. In addition, although the normal spark of standard motor  
vehicle spark plug systems generating about 25000 to 28000 volts may be used, it is  
presently preferred to generate a hotter spark, e.g., generated by about 35000 volts. Electric  
10 spark generating systems are available of up to 90000 volts and it appears that higher  
voltages result in better dissociation of water molecules in the combustion chamber.

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### Detailed Description of the Preferred Embodiment

As indicated previously, one of the advantages of the invention is that internal combustion engines may be operated with novel fuels and fuel mixtures that require significantly less combustion air for combustion of the fuel in the engine's combustion chamber. For example, gasoline used as fuel for an internal combustion engine employing a carburetor generally requires an air to fuel ratio of 14 to 16:1 to produce satisfactory power output to operate the engine and power a motor vehicle. Alcohol, such as pure ethanol, may utilize an air to fuel ratio of 8 or 9:1 for satisfactory performance of the same engine. In contrast to such conventional fuels, the aqueous fuel of the present invention utilizes a lesser, controlled amount of combustion air. It has been determined that it is critical for the practice of the invention to employ an air to fuel ratio of not greater than 5:1 for equivalent satisfactory performance of an internal combustion engine. The preferred air to fuel ratio in accordance with the invention is from 0.5:1 to about 2:1; with an optimum air to fuel ratio in the range of 0.75:1 to 1.5:1 and, most optimally 1:1.

The reason that the aqueous fuel and the fuel mixture of the present invention can produce satisfactory internal combustion engine results is that in practicing the invention hydrogen and oxygen are released in the combustion chamber. The hydrogen and oxygen result from dissociation of water molecules and the hydrogen is combusted along with the carbonaceous fuel of the aqueous mixture. The result is that comparable engine power output is achieved with less carbonaceous fuel and less combustion air than can be achieved using conventional combustion of the same carbonaceous fuel with greater amounts of combustion air.

It is further noted that with the aqueous fuel of the present invention the water component vaporizes as steam in the combustion chamber. Steam expands to a greater extent than air and the combustion chamber can be suitably filled with less combustion air. Thus, the water component of the fuel transforms to steam which expands in the combustion chamber and replaces a portion of the combustion air used in combusting conventional fuels in the engine's combustion chamber. The expansion of the steam together with the combustion of the hydrogen released by dissociation of the water molecules results in generation of the required power output necessary for satisfactory operation of the engine.

It has been previously pointed out, that the amount of combustion air provided in the combustion chamber for combustion with the aqueous fuel of the invention must be critically controlled so that an air to fuel ratio of not greater than 5:1 is present during combustion. It has been determined that if too much air, i.e., greater than a ratio of air to fuel of 5:1, is introduced with the aqueous fuel into the combustion chamber, incomplete combustion of the carbonaceous fuel results because of the excess of oxygen in the combustion chamber. Excess oxygen over that required to combust the carbonaceous fuel results when the ratio of air to fuel is too high due to a combination of the amount of oxygen released from dissociation of the water molecules and the additional oxygen present in an excessive amount of combustion air. Incomplete combustion of the carbonaceous fuel results in unsatisfactory performance of the engine as well as excess emission of undesirable pollutants. By reducing

1 the amount of combustion air required for combustion in the combustion chamber, less  
nitrogen is present in the combustion chamber to combine with oxygen and form undesirable  
NOX pollutants emitted during engine operation. Thus, one important advantage of the  
5 invention is the considerable reduction in NOX and other undesirable emission pollutants  
over that which are produced by conventionally operated internal combustion engines using  
conventional carbonaceous fuels such as gasoline, diesel fuel, etc. in internal combustion  
engines.

It is also noted that since hydrogen and oxygen and oxygen are present in the fuel  
mixture to be combusted in the combustion chamber of an internal combustion engine, in  
10 accordance with the invention, circumstances may arise in which too little water in the  
aqueous fuel would be unsatisfactory. For example, where the carbonaceous fuel has a low  
inherent energy output, i.e. low potential energy of BTU output per unit volume, greater  
amounts of water may be desirable because the release of hydrogen and oxygen by  
dissociation of water molecules and combustion of the hydrogen will usefully increase the  
15 total energy output of the carbonaceous fuel and water mixture. For this reason, a lower  
limit of between 20 and 25% water, e.g., greater than 20% water, is established as the  
useful, practical, minimum amount of water in the aqueous fuel mixture of the present  
invention so as to accommodate a greater variety of carbonaceous fuels within the scope of  
the invention. The upper limit of 70% to 80% water is established because a minimum  
20 amount of gaseous or liquid carbonaceous fuel is need to initiate the reaction, triggered by  
a spark generated in the combustion chamber that dissociates the water molecules in the  
combustion chamber. It has been determined that from 30,000 BTU energy/gal. of fuel to  
60,000 BTU energy/gal. of fuel is preferred for the water dissociation reaction.

The aqueous fuel of the present invention comprises water from greater than about  
20 percent to about 70 to 80 percent by volume of the total volume of the aqueous fuel and,  
preferably, a volatile liquid carbonaceous fuel, such as a fuel selected from the group  
25 consisting of alcohols, e.g., ethanol or methanol, gasoline, diesel fuel, kerosene-type fuel,  
or mixtures thereof. Alcohols such as ethanol and methanol generally contain small  
percentages of water when produced commercially and, of course, include oxygen and  
hydrogen in the molecular structure. Commercial grades of ethanol and methanol are  
marketed in terms of a proof number, such as for example, 100 proof ethanol. One half the  
30 proof number is generally an indication of the amount of ethanol present, i.e., 100 proof  
ethanol contains 50 vol percent ethyl alcohol and 50 percent water; 180 proof ethanol  
contains 90 percent of ethyl alcohol and 10 percent of water, etc.

The aqueous fuel of the present invention is believed to be usable in all internal  
combustion engines, including conventional gasoline or diesel powered internal combustion  
engines for use in automobiles, trucks and the like, using conventional carburetors or fuel  
35 injection systems as well as rotary engines and turbine (jet) engines. The invention is  
believed to be useable in any engine in which volatile liquid carbonaceous fuel is combusted  
with oxygen ( $O_2$ ) in one or more combustion chambers of the engine.

1 Few modifications are necessary to make such engines usable with the fuel of the  
present invention. For example, installation of a hydrogen-producing catalyst in the  
combustion chamber or chambers of the engine, such as described elsewhere herein, to act  
5 as a catalyst in the dissociation of water molecules to yield hydrogen and oxygen must be  
made. In addition, suitable means to supply and control the input, quantity and flow, of  
combustion air and fuel to the combustion chamber(s) is important for optimum engine  
operation. It is noted in this regard that the air:fuel ratio is a significant factor in effecting  
combustion in the chamber(s). It is also desirable, from a practical point of view, to make  
10 the fuel supply and fuel storage systems of rust proof materials. A higher voltage electric  
spark system than generally used in internal combustion engines of motor vehicles operated  
with conventional carbonaceous fuels, e.g., gasoline, is also preferred. Systems to provide  
a "hotter spark" are available commercially, such as from Chrysler Motor Company. As a  
further modification to optimize use of the invention, it is desirable to employ a computer  
15 assisted electronically controlled system to supply fuel to fuel injectors during the intake  
stroke of the internal combustion engine.

The dissociation of water molecules, per se, is well known. For example, the  
thermo-dynamics and physical chemistry of water/steam dissociation are described in the  
text entitled "Chemistry of Dissociated Water Vapor and Related Systems" by M.  
20 Vinugopalan and R.A. Jones, 1968, published by John Wiley & Sons, Inc.; "Physical  
Chemistry for Colleges", by E.B. Mellard, 1941, pp 340-344 published by McGraw-Hill  
Book Company, Inc., and "Advanced Inorganic Chemistry", by F. Albert Cotton and  
Geoffrey Wilkinson, 1980, pp 215-228; the disclosures of which are expressly incorporated  
herein by reference.

Although not required for the practice of the invention, a heater to preheat the  
combustion air for the engine and a heat exchanger to use the hot exhaust gases from the  
25 engine to preheat the combustion air after the engine is operating, at which time the heater  
is shut off, may also be installed. Although the presently preferred embodiment of the  
invention does not require preheating combustion air and/or fuel, combustion air for the  
engine may be preheated before it is introduced into a carburetor or fuel injection system.  
When using an engine with a carburetor, the combustion air may be preheated to from about  
30 350°F to about 400°F as it enters the carburetor. When using an engine with a fuel  
injection system, the combustion air may be preheated from about 122°F to about 158°F as  
it enters the fuel injection system. In such cases, the aqueous fuel of the present invention  
is introduced into the carburetor or fuel injection system and is mixed with a controlled  
amount of combustion air. The aqueous fuel is preferably introduced into the carburetor or  
fuel injection system at ambient temperatures.

35 In the preferred embodiment, aqueous fuel and combustion air are introduced into the  
carburetor or fuel injection system at ambient temperatures and the air/fuel mixture is then  
introduced into the combustion chamber or chambers where a spark from a spark plug ignites  
the air/fuel mixture in the conventional manner when the piston of the combustion chamber  
reaches the combustion stage of the combustion cycle. The presence of a hydrogen-

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1 producing catalyst in the combustion chamber is believed to act as a catalyst for the  
dissociation of water molecules in the aqueous fuel when the spark plug ignites the air/fuel  
mixture. The hydrogen and oxygen released by dissociation are also ignited during  
5 combustion to increase the amount of energy delivered by the fuel. It has been observed in  
experiments using 100 proof alcohol as the engine fuel that the engine produced the same  
power output, i.e., watts per hour, as is produced with the same volume of gasoline. This  
is indeed surprising in view of the fact that the 100 proof ethanol has a theoretical energy  
potential of about 48,000 BTU's per gallon, with a usable potential of about 35,000 to  
10 37,500 BTU's per gallon, as compared to gasoline, which has an energy potential of about  
123,000 BTU's per gallon, nearly three times as much. The fact that the lower BTU ethanol  
is able to generate as much power as a higher BTU gasoline suggests that additional power  
is attributable to the liberation, i.e., dissociation, and combustion of hydrogen and oxygen  
from the water.

15 Inasmuch as 100 proof ethanol has been found to be a satisfactory fuel in using the  
method of the present invention, it is apparent that other suitable fuels may be made by  
blending by use of other alcohols and by blending alcohols with gasoline, kerosene type fuels  
or diesel fuel, depending on whether the fuel is to be used in a gasoline, turbine or diesel  
powered engine. Experimental work also indicates that 84 proof (42 percent water) ethanol  
may also be used as a fuel and it is believed that aqueous fuels containing as much as 70 to  
20 80 percent water may be used.

#### The Engine with Carburetor

25 To demonstrate one embodiment of the present invention, an engine was selected  
which also had the capacity to measure a predetermined workload. The engine selected was  
a one-cylinder, eight horsepower internal combustion engine connected to a 4,000 watt per  
hour a/c generator. The engine/generator was manufactured by the Generac Corporation of  
Waukesha, Wisconsin under the trade name Generac, Model No. 8905-0(S4002). The  
engine/generator is rated to have a maximum continuous a/c power capacity of 4,000 watts  
(4.0 KW) single phase.

30 The engine specifications are as follows:

Engine Manufacturer - Tecumseh

Manufacturer's Model No. - HM80 (Type 155305-H)

Rated Horsepower - 8 at 3600 rpm

35 Displacement - 19.4 cubic inches (318.3 cc)

Cylinder Block Material - Aluminum with cast iron  
sleeve

Type of Governor - Mechanical, Fixed Speed

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1                   **Governed Speed Setting** - 3720 rpm at No-Load (Rated a/c frequency and voltage (120/240 volts at 62 hertz) are obtained at 3600 rpm. The no-load setting of 3720 rpm provides 124/248 volts at 62 hertz. A slightly high no-load setting helps ensure that engine speed, voltage and frequency do not drop excessively under heavier electrical loading.)

5                   **Type of Air Cleaner** - Pleated Paper Element

**Type of Starter** - Manual, Recoil Rope

**Exhaust Muffler** - Spark Arrestor Type

10                  **Ignition System** - Solid State with Flywheel Magneto

**Spark Plug** - Champion RJ-17LM (or equivalent)

**Set Spark Plug Gap to** - 0.030 inch (0.76mm)

**Spark Plug Torque** - 15 foot-pounds

15                  **Crankcase Oil Capacity** - 1-1/2 pints (24 ounces)

**Recommended Oil** - Use oil classified "For Service       SC, SD or SE"

**Primary Recommended Oil** - SE 10W-30 Multiple Viscosity Oil  
                          **Acceptable Substitute** - SAE 30 Oil

**Fuel Tank Capacity** - 1 gallon

20                  **Recommended Fuel** -

**Primary** - Clean, Fresh UNLEADED Gasoline  
                          **Acceptable Substitute** - Clean, Fresh, Leaded REGULAR Gasoline

25                  A heat exchanger was installed on the engine to use the hot exhaust gases from the engine to preheat the air for combustion. A platinum bar was installed at the bottom surface of the engine head forming the top of the combustion chamber. The platinum bar weighed one ounce and measured 2-5/16 inches in length, 3/4 inches in width, and 1/16 inch in thickness. The platinum bar was secured to the inside of the head with three stainless steel screws.

30                  A second fuel tank having a capacity of two liters was secured to the existing one-liter fuel tank. A T-coupling was inserted into the existing fuel line of the motor for communication with the fuel line for each fuel tank. A valve was inserted between the T-coupling and the fuel lines for each fuel tank so that either tank could be used separately to feed fuel to the carburetor or to mix fuels in the fuel line leading to the carburetor.

### 35                  TEST RUNS

                  A series of tests were performed to determine if 100 proof ethanol (50% ethanol by volume, balance water) could be used in the motor which was modified as described above, and if so, to compare the performance of the 100 proof ethanol with the same amount of gasoline.

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1 Two liters of unleaded gasoline were poured into the second fuel tank with the valve for the second tank in the closed position. Three and eight tenths liters of 100 proof ethanol were poured into the one gallon fuel tank with the valve in the closed position. The valve for the gasoline tank was opened so that the engine could be initially started on gasoline.

5 Within three minutes of starting the motor, the combustion air entering into the carburetor was measured at 180°F. At this point, the fuel valve under the ethanol tank was opened and the valve under the gasoline tank was closed. At that point, the temperature of the air entering the carburetor had risen to 200°F.

10 Ethanol was now the primary fuel in the motor which exhibited a certain amount of roughness during operation until the choke mechanism was adjusted by reducing the air intake to the engine by approximately 90 percent. Immediately thereafter, two, 1800 watt, heat guns, having a rated heat output of 400°F, were actuated and used to heat the combustion air as it entered the carburetor. The temperature of the air from the heat guns measured 390° to 395°F.

15 After the engine ran on ethanol for approximately 20 minutes, the heat measurement in the incoming combustion air stabilized between 347°F and 352°F. The engine was run on the 100 proof ethanol fuel for 40 additional minutes, for a total of one hour, until two liters of ethanol had been used. The valve under the ethanol tank was then closed and the engine was turned off by opening the choke. Eighteen hundred milliliters of ethanol were left remaining in the tank.

20 The choke was then reset to the 90 percent closed position, and the engine was started once again. The engine responded immediately and ran as smoothly on 100 proof ethanol as it did during the one-hour operation.

The engine was stopped and started in the same manner on three separate occasions thereafter with the same results.

25 While operating the engine on 100 proof ethanol, the power output on the generator was measured and indicated that the ethanol produced 36,000 watts of power during a one-hour period using two liters of ethanol having energy potential of about 48,000 BTUs per gallon.

30 After the engine had stopped running on ethanol, it was operated again with the two liters of gasoline in the gasoline tank. Forty seven minutes into the test, the engine stopped because it ran out of gasoline. Measurements taken on the generator indicated that, when the engine was operated on gasoline, it was producing power at a rate of 36,000 watts per hour for 47 minutes, using two liters of gasoline having an energy potential of about 123,000 BTUs per gallon.

35 Comparing these power measurements indicates that two liters of 100 proof ethanol produced the same amount of power as two liters of gasoline. This is surprising inasmuch as the gasoline has about 2.5 times as many BTUs as the same amount of 100 proof ethanol. This indicates that the extra power from the ethanol must be due to the liberation and combustion of hydrogen and oxygen from the relatively large amounts of water in the fuel.

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1 Although gasoline was used as the starter fuel to preheat the engine and, thus,  
generate hot exhaust gases to preheat the combustion air, the use of the gasoline as the starter  
fuel for preheating is not necessary and could be replaced with an electrical heat pump to  
5 preheat the combustion air until the heat exchanger can take over and preheat the combustion  
air, whereupon the electrical heat pump would turn off.

The above tests comparing the use of the 100 proof ethanol and gasoline were  
repeated on three subsequent occasions, each with the same results.

10 A second series of tests were run which were identical to the above, except for the  
use of 84 proof ethanol (42 percent ethyl alcohol and 58 percent water) in place of the 100  
proof ethanol. However, after running about 30 seconds on the 84 proof ethanol, the engine  
stopped abruptly and released a fair amount of oil under high pressure from the main bearing  
in the main engine. The engine was restarted and abruptly stopped again after operating for  
about 20 seconds.

15 The above stoppage appears to have been due to preignition of the hydrogen and/or  
oxygen during the up-stroke period of the piston which caused pressure build-up in the crank  
case, which in turn forced oil under pressure through the main bearing. The pressure inside  
the combustion chamber appears to have been relieved through the piston rings into the crank  
case, and then relieved through the main bearing.

20 The premature ignition of the hydrogen and/or oxygen was probably caused by  
generating a larger amount of oxygen and hydrogen which did not occur when using 100  
proof ethanol having a lesser amount of water.

25 The preignition problem is believed to be curable by using an engine having a shorter  
piston stroke to reduce the dwell time of the fuel, including hydrogen and oxygen, in the  
combustion chamber, or by adjusting the carburetor or the electronically controlled fuel  
injection system to help reducing dwell time to avoid generating excessive amount of  
hydrogen and oxygen. The engine used in the experiment had a relatively long piston stroke  
of 6 inches. For the conditions described above, the piston stroke should be no more than  
about 1-1/2 inches or less to avoid the preignition problem in that particular engine.

#### ENGINE WITH ELECTRONICALLY CONTROLLED FUEL INJECTION SYSTEM

30 A series of tests were run on an engine having an electronically controlled fuel  
injection system to determine if that would solve the preignition problem discussed above.  
The engine used for this purpose was a 3-cylinder turbo charge electronically controlled  
internal combustion engine from a 1987 Chevrolet Sprint which had been driven about  
35 37,000 miles.

The head was removed from the motor block and cleaned to remove carbon deposits.  
Three platinum plates were attached to the inside of each head so as not to interfere with  
valves moving inside the heads during operation. Each platinum plate was 1 centimeter in  
length and width and was 1/32 of an inch in thickness. Each platinum plate was attached

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1 to a head with one stainless steel screw through the center of each piece. Carbon deposits were cleaned off each piston head and the engine was reassembled using new gaskets.

5 The combustion air intake hose which exits from the turbo and leads to the injector module was divided in the middle and attached to a heat exchanger to cool the combustion air delivered to the injector. The heat exchanger was bypassed by using two Y-junctions on either side of the heat exchanger and by putting a butterfly valve on the side closest to the turbo so that the hot air stream could be diverted around the heat exchanger and introduced directly into the injector module. All pollution abatement equipment was removed from the engine but the alternator was kept in place. The transmission was reattached to the engine because the starter mount is attached to the transmission. The transmission was not used during the testing. This engine was inserted into a Chevrolet Sprint car having a tailpipe and muffler system so that the engine was able to run properly. The catalytic converter was left in the exhaust train but the inside of the converter was removed as it was not needed. Two one-gallon plastic fuel tanks were hooked up to the fuel pump by a T-section having manual valves so the fuel to the fuel pumped could be quickly changed by opening or closing the valves.

#### TEST RUNS

20 A series of test runs were performed to determine how the engine as modified above would run using a variety of fuels.

The first test utilized 200 proof methanol as a starter fluid. The engine started and operated when the fuel pressure was raised to 60 to 75 lbs. When using gasoline, the fuel pressure is generally set at 3.5 to 5 lbs.

25 While the engine was running on the 200 proof methanol, the fuel was changed to 100 proof denatured ethanol and the motor continued operating smoothly at 3500 revolutions per minute (rpm). After about two minutes the test was stopped and the engine shut down because the fuel hoses were bulging and became unsafe. These hoses were replaced with high pressure hoses and the plastic couplings and the T's were also replaced with copper couplings and T's. A new pressure gage was attached. During the testing, it was noted that the fuel mixture needed more combustion air and that the computerized settings of the engine could not be adjusted to provide the additional air. To overcome this, the air intake valve was opened.

30 After these modifications, a new series of tests were performed using 200 proof methanol in one of two fuel tanks. The engine started on the 200 proof methanol and the rpm setting was adjusted to 3500. The engine was allowed to run for a few minutes. During that time, the fuel pressure was adjusted and it was noted that 65 lbs. of pressure appeared to be adequate. A thermocouple was inserted close to the injector module and provided a reading of 65°C after about 5 minutes.

35 A fuel mixture comprising 500 ml of distilled water and 500 ml of 200 proof methanol were put into the second fuel tank this fuel and was used to operate the engine.

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1 Without changing the air flow, the temperature of the combustion air rose from 65 to 75°C after about 1 minute. The rpm reading dropped to 3100 rpm. The engine ran very smoothly and was turned off and restarted without difficulty.

5 The next step in the test series was to determine how variations in the water content of the fuel effected engine performance. Using 199 proof denatured ethanol as starter fuel, the engine started immediately. The fuel pressure setting was reduced from 65 lbs. to 50 lbs, the combustion air measured 65°C, the rpm's measured 3500, and the engine ran smoothly.

10 The fuel was then changed into 160 proof denatured ethanol. The fuel pressure was maintained at 50 lbs. The combustion air temperature was measured at 67°C, the rpm's decreased to 3300, and the engine ran smoothly.

After 10 minutes, the fuel was changed to 140 proof denatured ethanol. The combustion air temperature rose to 70°C, the rpm's rose to 3500, and the engine ran smoothly.

15 After 10 minutes, the fuel was changed to 120 proof denatured ethanol. The combustion air temperature increased to 73°C, the rpm's decreased to 3300, and the engine ran smoothly.

After 10 minutes, the fuel was changed to 100 proof denatured ethanol. The combustion air temperature increased to 74°C, the rpm's decreased to 3100, and the engine ran smoothly.

20 After 10 minutes, the fuel was changed to 90 proof denatured ethanol. The combustion air temperature remained at 74°C, the rpm's reduced to 3100, and the engine ran smoothly.

25 After 10 minutes, the fuel was changed to 80 proof denatured ethanol. The combustion air temperature raised to 76°C and the rpm's reduced to 2900. At that point, an infrequent backfire was noted in the engine. 100 proof denatured ethanol was then used as the primary fuel and the bypass to the heat exchanger was closed. The combustion air temperature rose to 160°C and during the next minutes increased to 170°C. The rpm's increased to 4000 rpm and the engine ran smoothly.

30 Another series of tests were run with the engine adjusted to operate at 3500 rpm's and with the heat exchanger removed so that neither the fuel or combustion air were preheated and thus were at ambient temperatures. The engine was started with 200 proof ethanol as the fuel and as soon as the intake air temperature at the injector module had risen to about 50°C, the fuel was changed to 100 proof ethanol and the engine ran smoothly. The intake air temperature rose to 70°C where it stabilized. The engine was turned off, restarted and continued to run smoothly. By adjusting and opening the air intake, the rpm could be increased to over 4000. By slightly closing the same air intake, the rpm could be reduced to 1500. At both ranges of rpm, the engine ran smoothly and was turned off and restarted without difficulty and continued to run smoothly.

35 The rpm of an engine using the method and fuel of the present invention may be regulated by regulating the amount of air flow into the combustion chamber. In a

1 conventional gasoline powered engine, the engine rpm is regulated by regulating the amount of gasoline that is introduced into the combustion chambers.

5 It is evident that the invention involves the use of an aqueous fuel which may comprise large amounts of water in proportion to volatile carbonaceous fuel. A particularly effective aqueous fuel comprises a mixture of approximately 70% water and 30% carbonaceous fuel. The thermal energy of the carbonaceous fuel, e.g., gasoline, is reduced from the fuels high energy value, approximately 120,000 BTU's per volume gallon in the case of gasoline, to a BTU content of approximately 35,000 BTU's per volume gallon for the 70% water, 30% gasoline mixture. This BTU content of the water/gasoline mixture is sufficient to maintain a reaction in the combustion chamber of an internal combustion engine, such that the water molecule is dissociated and the hydrogen molecule ( $H_2$ ) is separated from the oxygen molecule ( $O_2$ ) and the so produced hydrogen gas is utilized as a primary power source to move the pistons inside an internal combustion engine upon combustion. The invention is applicable with a variety of volatile carbonaceous fuels, including diesel oil or kerosene, and those fuels can be also mixed with up to 80% water (e.g., diesel or kerosene) to achieve the same reaction to dissociate hydrogen and oxygen to release hydrogen gas to power an internal combustion engine in the presence of a hydrogen-producing catalyst.

15 For this reaction to take effect, it is necessary to equip each combustion cavity inside the internal combustion engine with at least one, but preferably two, and maybe more, poles of hydrogen producing catalyst, with a melting point above the temperature of combustion. Useful catalysts include Ni, Pt, Pt-Ni alloys, Ni-stainless steel, noble metals, Re, W, and alloys thereof, which may be utilized as a hydrogen producing catalyst in the form of catalytic metal poles. Combustion and dissociation is initiated by a spark which may be created by a conventional electric spark generation system such as is used with conventional motor vehicle engines.

20 As a further examples of the invention, using fuel and combustion air at ambient temperatures I took 3 liters of unleaded gasoline (87 octane) with a BTU content of about 120,000 BTU's per gallon and 7 liters of tap water. I added 10ml of surfactant (detergent) into this mixture in a first test to enhance mixing of the water with the gasoline. This procedure was followed to produce additional mixtures with 25 ml and 40 ml of surfactant to obtain the water/gasoline mixture. The same procedure was also followed with using tap water which was filtered through a deionization unit and charcoal filter to remove the chlorine and other impurities present in the water.

25 Each of the above described mixtures was then tested in a 4 cylinder, 2.5 liter internal combustion engine equipped with injectors, which were attached to a fuel rail. The fuel used during those tests was disbursed to the fuel rail through a Bosch multi-port pressure measuring device. The engine was also equipped with a fuel carburetor. The carburetor is only used for the air intake into the engine as the air/fuel ratios are substantially lower and differ with the various fuels used; for example, starting at 0.75:1 with the 50/50 water/alcohol mixture and from 1:1 to 3:1 for the 70% water/30% gasoline mixture.

1 Normally, a gasoline engine using gasoline as fuel utilizes an air fuel ratio of 14 to 1. Such  
an engine is equipped with a cylinder but is changed to accept two 1/2-inch diameter nickel  
bolts or screws, as the hydrogen-producing catalyst, with the screw part being of 1/4-inch  
5 diameter to practice the invention. The nickel bolts were placed 1/2-inch apart on top of the  
piston. In another modification I placed a flat piece of aluminum (6-inches by 12-inches)  
inside and on top of the engine head. I drilled and tapped three 3/4-inch holes into the cover  
10 of the engine head in a horizontal position approximately 3-1/2 inches apart. I screwed some  
copper adapters into those holes. The adapters are connected with each other by a 3/4-inch  
copper pipe which was fitted into the muffler. This device carries the exhaust gas from the  
engine and I have found that it is sufficient to take out water vapors (steam) from the head,  
otherwise the water vapor will accumulate in the engine and crankcase oil, which is not  
desirable.

Each of the above mentioned fuel mixtures were tested while the engine was in  
neutral so as not to move the car and were found to be capable of self starting the engine  
15 by just turning the ignition key of the car. It was not necessary to use a secondary fuel to  
start the engine.

The 2.5 liter engine utilized in those tests was in a standard 2.5 liter Chrysler turbo  
injection engine with the turbo and all smog and pollution abatement equipment removed.  
This engine also had a factory installed 3-speed automatic transmission with a gear ratio of  
20 1:3.09.

The same test series as mentioned above was also performed utilizing the same  
internal combustion engine and car, with approximately from 20% to 25% diesel and 75%  
to 80% water, with the same results. Additional tests were conducted with from 20% to  
25% kerosene fuel and from 75% to 80% water where like results were also obtained.

25 In another test series, I used a 70% water/30% gasoline emulsified mixture as the  
only fuel to power the engine in a test "City Car", which I developed for testing purposes.  
This car is a 4 door, 5 passenger front wheel drive car with a net weight of 2,500 pounds.  
In tests I was able to drive this car with the above mentioned fuels from 0 to 60 miles per  
hour in about 6 seconds. I tested the car to a top speed of 75 miles per hour but the car  
could be driven substantially faster.

30 As discussed above, I have also determined that it is important to control the air to  
fuel mixture to obtain optimum results. In one test, I ran a 14:1 air fuel ratio, the same as  
conventionally used with gasoline, and this resulted in an incomplete combustion within the  
engine and large amount of water and fuel mixture exiting the tail pipe. The same occurred  
using an air to fuel mixture of 7:1. These tests were conducted using water and gasoline at  
a 70% to 30% mixture, water and diesel at a 75% to 25% mixture and water and kerosene  
35 at a 75% to 25% mixture. The incomplete combustion began to subside to satisfactory levels  
with air to fuel ratios of 3:1 or less. Outer limits and optimum properties are easily  
determined for any given aqueous fuel mixture using the procedure described above but the  
air to fuel ratio should not exceed 5:1.

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1 I have also found that a wetting agent or surfactant may be desirable. One such agent which has proved to be useful has a trade name of Aqua-mate<sup>2</sup> manufactured or distributed by Hydrotex in Dallas, Texas. Obviously, other wetting agents available commercially that help disperse carbonaceous fuels in water are also usable.

5 I additionally conducted tests on all three above described fuels using 50% water and 50% carbonaceous fuel, e.g., oil based fuel, which was adequately dispersed in the water. These tests also allowed the engine to run very satisfactorily.

10 Another car test is in progress using 50% water and 50% alcohol, with an energy content of 35,000 BTU's per gallon. Test results of 20 miles per gallon of actual driving have been achieved. With proper fuel management in the engine, efficiency can be effectively increased significantly upwards to 30 miles per gallon or more.

15 The benefits of the invention are substantial since about a 70% reduction of air pollutants is obtained with a total elimination of NOX. There is also a 70% reduction of the fuel price to drive a vehicle through reduction in the amount of gasoline used. Furthermore, there are other substantial advantages; such as possible reduction of elimination of need for oil imports.

Other gaseous or liquid carbonaceous fuels may be used, including gaseous fuels such as methane, ethane, butane or natural gas and the like which could be liquified and substituted for ethanol and methanol as used in the present invention, or used in gaseous form.

20 The present invention could also be used in jet engines, which is another form of internal combustion engine.

25 While the embodiments of the invention chosen herein for purposes of the disclosure are at present considered to be preferred, it is to be understood that the invention is intended to cover all changes and modifications of all embodiments which fall within the spirit and scope of the invention, wherein what is claimed is:

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1. A method for combusting an aqueous fuel in an internal combustion engine having one or more combustion chambers, a fuel introduction system for receiving and mixing said fuel and combustion air and introducing said fuel and air mixture into said combustion chamber or chambers and an electric spark producing system for creating a spark in said combustion chamber or chambers, said method comprising:  
introducing combustion air in controlled amounts into said fuel introduction system,  
introducing said aqueous fuel into said fuel introduction system to mix with said combustion air, said aqueous fuel comprising water from about 20 percent to about 80 percent by volume of the total volume and a liquid or gaseous carbonaceous material, and  
introducing and combusting said aqueous fuel and combustion air in said combustion chamber or chambers in the presence of a hydrogen-producing catalyst to operate said engine, said combustion being initiated by a spark generated in said combustion chamber or chambers.
2. A method according to claim 1 wherein the combustion in the chamber or chambers is initiated by a spark of at least 35000 volts.
3. A method according to claim 1 wherein the hydrogen-producing catalyst is present as at least one, and preferably a plurality of, catalytic poles.
4. The method according to claim 1 wherein said carbonaceous fuel is selected from the group consisting of alcohols, preferably ethanol or methanol, gasoline, kerosene fuel, diesel fuel, other carbon-containing gaseous or liquid fuels, or mixtures thereof, in amounts of about 25% to 75%, preferably about 40% to about 70%, of the total volume of said aqueous fuel.
5. A method according to claim 1 wherein the ratio of air to fuel in the mixture introduced into the combustion chamber(s) is not greater than 5:1.
6. A method according to claim 1 wherein the ratio of air to fuel in the mixture introduced into the combustion chamber(s) is 0.75:1 to 1.5:1, preferably 1:1.
7. The method according to claim 1 wherein said aqueous fuel and combustion air are introduced into said fuel introduction system at ambient temperatures.
8. The method according to claim 1 wherein said combustion air is initially heated prior to induction to the combustion chamber by a heater and then heated by heat from hot exhaust gases from said engine after the engine is operating.

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1           9.     The method according to claim 1 wherein said catalyst comprises at least one  
catalytic pole selected from the group consisting of nickel, platinum, platinum-nickel alloy,  
nickel-stainless steel, noble metals, rhenium, tungsten, alloys thereof, and other materials that  
5           will act as a catalyst for the dissociation of water molecules to produce hydrogen when said  
combustion air and said aqueous fuel are combusted in the presence of said catalyst and an  
electric spark.

10           10.    The method according to claim 9 wherein said catalyst is platinum.

10           11.    The method according to claim 9 wherein said catalyst comprises catalytic  
poles of nickel and nickel containing alloys.

15           12.    The method according to claim 1 wherein the power output of the engine is  
regulated by regulating the air flow into the fuel introduction system.

15           13.    A method according to claim 1 wherein said engine comprises an engine from  
the group consisting of a rotary engine, a turbine engine and an engine with one or more  
working cylinders in which the process of combustion takes place within the cylinders.

20           14.    A method for combusting an aqueous fuel in an internal combustion engine  
having: (a) one or more combustion chambers, (b) a fuel introduction system for receiving  
and mixing fuel and combustion air and introducing said fuel and air mixture into said  
combustion chamber or chambers and (c) an electric spark producing system for creating a  
spark in said combustion chamber or chambers, said method comprising:

25           introducing combustion air in controlled amounts into said fuel introduction  
system,

25           introducing aqueous fuel into said fuel introduction system to mix with said  
combustion air, said aqueous fuel comprising water from about 20 percent to about 80  
percent by volume of the total volume of said fuel, preferably 40% to 70%, and a  
carbonaceous fuel selected from the group consisting of alcohols, preferably ethanol or  
methanol, gasoline, diesel fuel, kerosene fuel, other carbon-containing gaseous or liquid  
30           carbonaceous fuels, or mixtures thereof, and

30           introducing and combusting said aqueous fuel and combustion air in said  
combustion chamber or chambers in the presence of a hydrogen-producing catalyst to operate  
said engine, said combustion being initiated by a spark generated in said combustion chamber  
or chambers.

35           15.    A method according to claim 14 wherein the combustion in the chamber or  
chambers is initiated by a spark of at least 35000 volts.

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16. A method according to claim 14 wherein the hydrogen-producing catalyst is present as at least one, and preferably a plurality of, catalytic poles.

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17. The method according to claim 14 wherein said catalyst is selected from the class consisting of nickel, platinum, platinum-nickel alloy, nickel-stainless steel, noble metals, rhenium, tungsten, alloys thereof, and other materials that will act as a catalyst for the dissociation of water molecules to produce hydrogen when said combustion air and said aqueous fuel are combusted in the presence of said catalyst and an electric spark.

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18. A method according to claim 14 wherein water molecules in the aqueous fuel are dissociated in said combustion chamber or chambers to release hydrogen and oxygen and wherein said hydrogen is combusted in said combustion chamber along with carbonaceous fuel.

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19. A method for combusting an aqueous fuel comprising a mixture of carbonaceous fuel and water in an internal combustion engine, said combustion being capable of producing approximately at least as much engine power as the same volume of said carbonaceous fuel would produce in said engine without water and a range of power output as indicated by a corresponding range of engine revolutions per minute (rpm); said engine having one or more combustion chambers, an electric spark producing system for creating a spark in said combustion chamber or chambers, and a fuel introduction system for (a) receiving and mixing said fuel with air for combustion, (b) controlling the proportions of fuel and air, and (c) introducing said fuel and air mixture into said combustion chamber or chambers; said method comprising:

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introducing aqueous fuel and controlled amounts of combustion air to said fuel introduction system for mixing therein, said aqueous fuel comprising water from about 20 percent to about 80 percent, preferably 40% to 70% by volume of the total volume of said fuel and a liquid or gaseous carbonaceous fuel, preferably a carbonaceous fuel comprising alcohol, such as ethanol or methanol, gasoline, kerosene fuel, diesel fuel, or mixtures thereof;

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introducing said mixture of aqueous fuel and combustion air into said combustion chamber or chambers in the presence of a hydrogen-producing catalyst in said combustion chamber or chambers; and

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combusting said aqueous fuel and air mixture to operate said engine, said combustion being initiated by a spark generated in said combustion chamber or chambers.

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20. A method according to claim 19 wherein the combustion in the chamber or chambers is initiated by a spark of at least 35000 volts.

21. A method according to claim 19 wherein the hydrogen-producing catalyst is present as at least one, and preferably a plurality of, catalytic poles.

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22. A method according to claim 19 wherein water molecules in the aqueous fuel are dissociated in said combustion chamber or chambers to release hydrogen and oxygen and wherein said hydrogen is combusted in said combustion chamber along with carbonaceous fuel.

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23. The method according to claim 19 wherein said carbonaceous fuel is selected from the group consisting of alcohols, gasoline, diesel fuel, kerosene fuel, and mixtures thereof, and the air to fuel ratio is controlled to be in the range of 0.75:1 to 1.5:1 and, preferably, 1:1.

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24. The method according to claim 19 wherein said hydrogen producing catalyst is selected from the group consisting of nickel, platinum, platinum-nickel, nickel-stainless steel, noble metals, rhenium, tungsten, alloys thereof and other materials that will produce hydrogen when said combustion air and said aqueous fuel are combusted in the presence of said catalyst and an electrically generated spark.

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25. A method of operating an internal combustion engine in a motor vehicle, said internal combustion engine being capable of producing a range of power output as indicated by a corresponding range of engine revolutions per minute (rpm) and having one or more combustion chambers, an electric spark producing system for creating a spark in said combustion chamber or chambers, and a fuel introduction system for (a) receiving and mixing fuel with air, (b) controlling the proportions of fuel and air and (c) introducing said fuel and air mixture into said combustion chamber or chambers, said method comprising:

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introducing combustion air in controlled amounts into said fuel introduction system,

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introducing aqueous fuel into said fuel introduction system to mix with said combustion air, said aqueous fuel comprising water from about 20 percent to about 80 percent by volume of the total volume of said fuel, preferably 40% to 70%, and a liquid or gaseous carbonaceous fuel, preferably a carbonaceous fuel, selected from the group consisting of alcohols, preferably ethanol or methanol, gasoline, diesel fuel or mixtures thereof, and

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introducing and combusting said aqueous fuel and combustion air in said combustion chamber or chambers in the presence of a hydrogen-producing catalyst to operate said engine, said combustion being initiated by a spark generated in said combustion chamber or chambers.

26. A method according to claim 25 wherein water molecules in the aqueous fuel are dissociated in said combustion chamber or chambers to release hydrogen and oxygen and wherein said hydrogen is combusted in said combustion chamber along with carbonaceous fuel.

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27. A method according to claim 26 wherein the amount of water in said aqueous fuel is 25% to 75% and the air to fuel ratio is controlled to be in the range of 0.75:1 to 1.5:1.

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28. A method according to claim 26 wherein said hydrogen-producing catalyst comprises catalytic poles selected from the group consisting of nickel, platinum, platinum-nickel alloy, nickel-stainless steel, noble metals, rhenium, tungsten, alloys thereof, and other materials that will act as a catalyst for dissociation of water molecules to produce hydrogen when said combustion air and said aqueous fuel are combusted in the presence of said catalyst and an electric spark.

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29. A method according to claim 28 wherein the combustion in the chamber or chambers is initiated by a spark of at least 35000 volts.

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30. A method according to claim 28 wherein the hydrogen-producing catalyst is present as at least one, and preferably a plurality of, catalytic poles.

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31. A novel aqueous fuel combustible with air in an internal combustion engine, said fuel comprising water from greater than 20 percent to about 80 percent, preferably 25% to 75%, by volume of the total volume of said fuel, and a liquid or gaseous carbonaceous fuel, preferably a carbonaceous fuel selected from the class consisting of alcohols, preferably ethanol or methanol, gasoline, kerosene fuel, diesel fuel, other carbon-containing gaseous or liquid fuels or mixtures thereof.

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32. A novel aqueous fuel according to claim 31 having 40% to 70% water.

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33. A fuel mixture for combustion in a combustion chamber in an internal combustion engine comprising aqueous fuel, gaseous or liquid carbonaceous fuel and hydrogen released from dissociation of water molecules, said aqueous fuel comprising initially water in an amount of from 20% to 80%, preferably 25% to 75%, by volume of the total volume of said aqueous fuel.

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34. A fuel mixture according to claim 33 wherein said carbonaceous fuel comprises alcohol, preferably ethanol or methanol, gasoline, diesel fuel, kerosene fuel, other carbon-containing gaseous or liquid fuels, or mixtures thereof.

35. A fuel mixture according to claim 33 having 40% to 70% water.

## AMENDED CLAIMS

[received by the International Bureau on 2 October 1991 (02.10.91);  
original claims 1-35 replaced by amended claims 1-14 (3 pages)]

1           1.     A method for combusting an aqueous fuel in an internal combustion engine  
having: (a) one or more combustion chambers, (b) a fuel introduction system for receiving  
and mixing fuel and combustion air and introducing said fuel and air mixture into said  
5     combustion chamber or chambers and (c) an electric spark producing system for creating a  
spark in said combustion chamber or chambers, said method comprising:

              introducing combustion air in controlled amounts into said fuel introduction  
system;

              introducing aqueous fuel into said fuel introduction system to mix with said  
combustion air, said aqueous fuel comprising water from about 20 percent to about 80  
10    percent by volume of the total volume of said fuel, and a carbonaceous fuel; and

              introducing and combusting said aqueous fuel and combustion air in said  
combustion chamber or chambers in the presence of a hydrogen-producing catalyst to operate  
said engine, said combustion being initiated by a spark generated in said combustion chamber  
or chambers.

15           2.     A method according to claim 1 wherein said carbonaceous fuel is selected  
from the group consisting of alcohols, preferably ethanol or methanol, gasoline, kerosene  
fuel, diesel fuel, other carbon-containing gaseous or liquid fuels, or mixtures thereof, and  
in water amounts of about 25% to 75%, preferably about 40% to about 70%, of the total  
volume of said aqueous fuel.

20           3.     A method according to claim 2 wherein the hydrogen-producing catalyst is  
present, as at least one, and preferably a plurality of, catalytic poles and the combustion in  
the chamber or chambers is initiated by a spark of at least 35000 volts.

25           4.     A method according to claim 2 wherein the ratio of air to fuel in the mixture  
introduced into the combustion chamber(s) is 0.75:1 to 1.5:1, preferably about 1:1.

30           5.     A method according to claims 1 or 2 wherein said catalyst comprises at least  
one catalytic pole selected from the group consisting of nickel, platinum, platinum-nickel  
alloy, nickel-stainless steel, noble metals, rhenium, tungsten, alloys thereof, and other  
materials that will act as a catalyst for the dissociation of water molecules to produce  
hydrogen when said combustion air and said aqueous fuel are combusted in the presence of  
said catalyst and an electric spark.

35           6.     A method according to claim 1 wherein said engine comprises an engine from  
the group consisting of a rotary engine, a turbine engine and an engine with one or more  
working cylinders in which the process of combustion takes place within the cylinders.

              7.     A method of operating an internal combustion engine in a motor vehicle, said  
internal combustion engine being capable of producing a range of power output as indicated

1 by a corresponding range of engine revolutions per minute (rpm) and having one or more  
combustion chambers, an electric spark producing system for creating a spark in said  
combustion chamber or chambers, and a fuel introduction system for (a) receiving and  
5 mixing fuel with air, (b) controlling the proportions of fuel and air and (c) introducing said  
fuel and air mixture into said combustion chamber or chambers, said method comprising:

introducing combustion air in controlled amounts into said fuel introduction  
system,

10 introducing aqueous fuel into said fuel introduction system to mix with said  
combustion air, said aqueous fuel comprising water from about 20 percent to about 80  
percent by volume of the total volume of said fuel, preferably 25% to 75%, and a liquid or  
gaseous carbonaceous fuel, preferably a carbonaceous fuel, selected from the group  
consisting of alcohols, preferably ethanol or methanol, gasoline, kerosene fuel, diesel fuel  
or mixtures thereof, and

15 introducing and combusting said aqueous fuel and combustion air in said  
combustion chamber or chambers in the presence of at least one, preferably a plurality of,  
catalytic poles of a hydrogen-producing catalyst to operate said engine, said combustion being  
initiated by a spark generated in said combustion chamber or chambers, preferably a spark  
of at least 35000 volts, the water molecules in the aqueous fuel being dissociated in said  
combustion chamber or chambers to release hydrogen and oxygen and said hydrogen being  
20 combusted in said combustion chamber along with carbonaceous fuel to produce energy to  
operate said engine.

8. A method according to claim 7 wherein the amount of water and the air to fuel  
ratio is controlled to be in the range of 0.75:1 to 1.5:1.

25 9. A method according to claim 7 wherein said hydrogen-producing catalyst  
comprises catalytic poles selected from the group consisting of nickel, platinum, platinum-  
nickel alloy, nickel-stainless steel, noble metals, rhenium, tungsten, alloys thereof, and other  
materials that will act as a catalyst for dissociation of water molecules to produce hydrogen  
when said combustion air and said aqueous fuel are combusted in the presence of said  
catalyst and an electric spark.

30 10. A novel aqueous fuel combustible with air in an internal combustion engine,  
said fuel comprising water from greater than 20 percent to about 80 percent, preferably 25%  
to 75%, by volume of the total volume of said fuel, and a liquid or gaseous carbonaceous  
fuel, preferably a carbonaceous fuel selected from the class consisting of alcohols, preferably  
35 ethanol or methanol, gasoline, kerosene fuel, diesel fuel, other carbon-containing gaseous or  
liquid fuels or mixtures thereof.

11. A novel aqueous fuel according to claim 10 having 40% to 70% water.

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12. A fuel mixture for combustion in a combustion chamber in an internal combustion engine comprising an aqueous fuel, said aqueous fuel comprising water molecules and gaseous or liquid carbonaceous fuel, and hydrogen released from dissociation of water molecules, said aqueous fuel comprising initially water in an amount of from 20% to 80%, preferably 25% to 75%, by volume of the total volume of said aqueous fuel.

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13. A fuel mixture according to claim 12 wherein said carbonaceous fuel comprises alcohol, preferably ethanol or methanol, gasoline, diesel fuel, kerosene fuel, other carbon-containing gaseous or liquid fuels, or mixtures thereof.

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14. A fuel mixture according to claim 12 wherein said aqueous fuel comprises initially 40% to 70% water.

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# INTERNATIONAL SEARCH REPORT

International Application No. **PCT/US91/03475**

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>6</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC  
**IPC(5): C10L 1/32; F02M 25/02; F02P 23/02**  
**U.S. Cl: 123/1A, 25B, 556; 44/301**

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>7</sup>

Classification System

Classification Symbols

U.S.

123/1A.3, 25R, 25B, 25E, 25F, 143B, 556, 670, DIG12; 44/301; 431/4

Documentation Searched other than Minimum Documentation  
to the extent that such Documents are included in the Fields Searched <sup>8</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	US, A, 4,333,739 Neves 08 June 1982 Column 6, lines 7-20, column 9, lines 1-25	31-35
X	US, A, 4,048,963 Cottell 20 September 1977 Column 2, lines 49-62, column 5, lines 1-9	31-35
X	US, A, 3,749,318 Cottell 31 July 1973 Column 4, lines 1-8	31-35
X	US, A, 4,831,971 Ott et al 23 May 1989 Column 6, lines 23-38	31, 33, 34
X	US, A, 4,110,973 Haeflich et al 05 September 1978 Column 4, lines 55-68	31, 33, 34
A	US, A, 3,208,441 Ottogy 28 September 1965	8
A	US, A, 2,656,830 Houdry 27 October 1953	1-30
A	US, A, 4,185,593 McClure 29 January 1980	1-30

\* Special categories of cited documents: <sup>10</sup>

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

02 July 1991

Date of Mailing of this International Search Report

30 JUL 1991

International Searching Authority

ISA/US

Signature of Authorized Officer

ISA/US  
T.M. Argenbright